

Application No.: 10/552,920

REMARKS

I. Introduction

For the reasons set forth below, Applicants respectfully submit that all pending claims as currently amended are patentable over the cited prior art.

II. The Rejection Of Claims 1 And 4-9 Under 35 U.S.C. § 103

Claims 1, 6 and 8 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Inoue (USP 5,707,756) in view of Goto et al. (US 2002/0094481); claims 4, 5 and 9 as being unpatentable over Inoue in view of Goto and further in view of Shoichiro et al. (JP 2002-319398); and claim 7 as being unpatentable over Inoue in view of Goto and further in view of Fernandez et al. (USP No. 5,637,413). Applicants respectfully traverse these rejections for at least the following reasons.

As a preliminary matter, the Office Action acknowledges that claims 10-13 were cancelled on page 1, section 1. However, in the detailed remarks in sections 3 and 4, the rejection of claims 10-13 is maintained. As claims 10-13 are not currently pending, appropriate correction of the record is respectfully requested.

With regard to the present disclosure, independent claim 1 recites, in-part, a non-aqueous electrolyte secondary battery comprising a positive electrode material mixture layer which comprises a positive electrode active material comprising a lithium transition metal composite oxide, wherein the lithium transition metal composite oxide is represented by the general formula (1): $\text{Li}_x\text{Co}_{1-y}\text{M}_y\text{O}_2$, the general formula (1) satisfies $1.0 \leq x \leq 1.03$ and $0.051 \leq y \leq 0.15$, the element M in the general formula (1) is at least two selected from the group consisting of Mg, Al, Sr, Mn, Ni and Ca.

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The negative electrode material mixture layer comprises a negative electrode active material comprising a carbon material that is capable of absorbing and desorbing lithium. The end of charge voltage of the non-aqueous electrolyte secondary battery is set to 4.25 to 4.5 V in normal operation. The ratio $R:W_p/W_n$ is 1.5 to 2.2 in the area where the positive electrode material mixture layer and the negative electrode material mixture layer are opposed to each other, the W_p being the weight of the positive electrode active material contained in the positive electrode material mixture layer per unit opposed area, said W_n being the weight of the negative electrode active material contained in the negative electrode material mixture layer per unit opposed area.

Independent claim 4 further includes a composite oxide B represented by the general formula (2): $Li_xNi_yMn_zM_{1-y-z}O_2$, where M is at least one selected from the group consisting of Co, Mg, Al, Ti, Sr and Ca.

Conventionally, the upper limit of the end of charge voltage is 4.2 in terms of having a stable positive electrode active material. Further, as batteries are regulated by the positive electrode to avoid deposition of lithium on the negative electrode upon overcharge, the positive electrode capacity is made smaller than the negative electrode. However, if the positive electrode capacity is too small, stability lessens at overcharge conditions. As such, the W_p/W_n ratio is generally kept at 2.2 or higher.

Thus, to improve capacity, heightening the end of charge voltage has been proposed. However, a high end of voltage charge causes large amounts of lithium ions to be released from the positive electrode active material. This increases the load, and subsequently decreases battery capacity, especially when the W_p/W_n ratio decreases.

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However, adding elements to the positive electrode active material may decrease the load of the positive electrode, even when large amounts of lithium ions are released. Yet, W_p/W_n ratios have generally been kept above 2.2 due to safety concerns.

Features of the present disclosure are that the lithium composite oxide is represented by the general formula (1): $Li_xCo_{1-y}M_yO_2$ satisfies $1.0 \leq x \leq 1.03$ and $0.051 \leq y \leq 0.15$ such that the amount of at least two of Mg, Al, Sr, Mn, Ni or Ca in the general formula is at least 0.051 as compared to the remainder of elements in the compound, that the end of charge voltage of the non-aqueous electrolyte secondary battery is set to 4.25 to 4.5 V in normal operation, and the ratio $R:W_p/W_n$ is 1.5 to 2.2.

As a result of these features, battery safety and positive electrode stability can be heightened, as a decrease in battery capacity can be suppressed. For example, as is shown in Table 2 of the specification, batteries 8 and 9 that have a W_p/W_n ratio of 2.3 to 2.4 show a significant effect on the capacity maintenance when an increase in end-of-charge voltage occurs. As the end of charge voltage increases from 4.25 V to 4.5 V, the capacity maintenance rate after cycling decreases by as much as 11 to 25% with the actual capacity maintenance rate at 4.5 V being from 40 to 59%. In contrast, batteries 4-7 which have a W_p/W_n ratio of 1.5 to 2.2, the decrease in capacity maintenance when end of charge voltage goes from 4.25 to 4.5 is only 0 to 6%, with the actual capacity maintenance rate from 73 to 80%.

In addition, Table 3 shows that the thermal stability of the batteries 4-7 is hardly affected by the increase in end of charge voltage, whereas the thermal stability of the batteries 3, 8 and 9 (battery 3 has a W_p/W_n of 1.4) is significantly affected. For example, when the end of charge voltage is 4.2 V, the thermorunaway threshold temperatures of all the batteries are about 175 °C, and as such, there is not much difference. However, when the end of charge voltage is 4.5 V, the

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thermorunaway threshold temperatures of batteries 3, 8 and 9 is 150 to 160 °C, which is a 10 to 18 °C decrease compared to at 4.2 V. However, with batteries 4-7 when the end of charge voltage is at 4.5 V, the thermorunaway threshold temperatures are as high as 170 to 172 °C, which is little change from the values at 4.2 V. Thus, the data shows that batteries within the claimed Wp/Wn range exhibit excellent stability characteristics at high end of charge values.

It is asserted that the combination of Inoue and Goto renders the pending claim 1 and 4 obvious. Applicants respectfully disagree.

Inoue fails to disclose a positive electrode active material including at least two metal elements in addition to lithium and cobalt and a Wp/Wn ratio of 1.5 to 2.2. The Examiner states that a skilled artisan can optimize the Wp/Wn ratio upon reading Inoue. However, it is also well known in the art that the Wp/Wn ratio is to be kept above 2.2, and accordingly, the optimization of Wp/Wn to the claimed range would not be considered a result effective variable. Nowhere in Inoue, or any other prior art is it considered to lower the Wp/Wn ratio to below 2.2. As such, the suggested combination does not teach or suggest a Wp/Wn ratio of 1.5 to 2.2.

Moreover, it is asserted that Goto teaches that batteries exhibit high discharge capacity maintenance rates, and therefore, it is obvious to modify the battery of Inoue with the positive electrode active material of Goto (see, ¶ [0114] of Goto). However, Goto only states that the high discharge capacity maintenance rate is ascribed to the inclusion of $\text{Li}_x\text{Fe}_{1-y}\text{M}_y\text{PO}_4$. Also, Goto shows that the use of $\text{LiCo}_{0.98}\text{Al}_{0.01}\text{Ni}_{0.01}\text{O}_2$ (Example 13 in Table 1) results in a low discharge capacity maintenance rate and corrosion of the copper negative electrode current collector (see, ¶ [0100], [0115] and [0116] of Goto). As such, a skilled artisan would not be motivated to combine the positive electrode active material of Goto with the battery of Inoue.

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Therefore, it is clear that Inoue, alone or in combination with Goto, fails to teach or suggest all of the limitations of claims 1 and 4 of the present disclosure. Moreover, Shoichiro does not, and is not relied upon to remedy this deficiency.

In order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. As Inoue, Goto and Shoichiro, at a minimum, fail to disclose a non-aqueous electrolyte secondary battery comprising a positive electrode material mixture layer which comprises a positive electrode active material comprising a lithium transition metal composite oxide, wherein said lithium transition metal composite oxide is represented by the general formula (1): $\text{Li}_x\text{Co}_{1-y}\text{M}_y\text{O}_2$, said general formula (1) satisfies $1.0 \leq x \leq 1.03$ and $0.051 \leq y \leq 0.15$, the element M in the general formula (1) is at least two selected from the group consisting of Mg, Al, Sr, Mn, Ni and Ca, it is submitted that Inoue, Goto and Shoichiro do not render claims 1 and 4 obvious. Accordingly, claims 1 and 4 are allowable and as such, it is respectfully requested that the § 103 rejection of claims 1 and 4, and any pending claims dependent thereon be withdrawn.

III. All Dependent Claims Are Allowable Because The Independent Claim From Which They Depend Is Allowable

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819 F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as claims 1 and 4 are patentable for the reasons set forth above, it is respectfully submitted that all pending dependent claims are also in condition for allowance.

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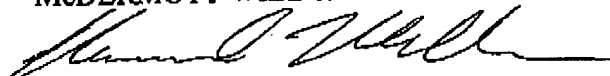
IV. Conclusion

Having responded to all open issues set forth in the Office Action, it is respectfully submitted that all claims are in condition for allowance.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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